

## 人工洞窟における地上レーザ測量データと3Dプリントの地盤工学的および教育的活用

### TLS measurement data and 3D printing of an artificial cave for geotechnical and educational applications

\*早川 裕弍<sup>1,2</sup>、小倉 拓郎<sup>4,5</sup>、田村 裕彦<sup>2</sup>、小口 千明<sup>3</sup>、清水 きさら<sup>3</sup>

\*Yuichi S. Hayakawa<sup>1,2</sup>, Takuro Ogura<sup>4,5</sup>, Yasuhiko Tamura<sup>2</sup>, Chiaki T. Oguchi<sup>3</sup>, Kisara Shimizu<sup>3</sup>

1. 北海道大学地球環境科学研究所、2. 東京大学空間情報科学研究センター、3. 埼玉大学、4. 東京大学新領域創成科学研究科、5. 北海道大学大学院環境科学院

1. Faculty of Environmental Earth Science, Hokkaido University, 2. Center for Spatial Information Science, The University of Tokyo, 3. Saitama University, 4. Graduate School of Frontier Science, The University of Tokyo, 5. Graduate School of Environmental Science, Hokkaido University

Conservation of an underground cultural heritage is often a controversial issue due partly to its invisibility and insufficient awareness in the local society. Also, the safety assessment is necessary to promote sustainable protection of an underground cultural heritage. The developments in high-definition topographic measurements enable to acquire detailed three-dimensional morphological data of a cave, which can be further utilized for the visualization and structural analyses. Regarding the measurements and visualization, we present a case study at the Taya Cave, a registered cultural heritage in Yokohama City, Kanagawa Prefecture in central Japan. The terrestrial laser scanning was performed from multiple scan positions throughout the cave, and the point clouds were registered using the feature-based iterated closest point algorithm. The registered point clouds were then converted into a mesh model, to which face error corrections and a solid filling were applied. After these processes, the mesh model can be printed out in three dimensions. The 3D print model of the cave is used for the class teaching in an elementary school in the local area, and such the visualization of the cave successfully enhanced the recognition by students regarding the underground cultural heritage. The 3D data can also be utilized for the structural assessment of the cave. Effective and sustainable protection of the cave will further be possible by integrating such geotechnical assessments and outreach activities in the local society.

キーワード：地上レーザ測量、点群、3Dプリント、アウトリーチ、地下文化財

Keywords: terrestrial laser scanning, point cloud, 3D printing, outreach, underground cultural heritage